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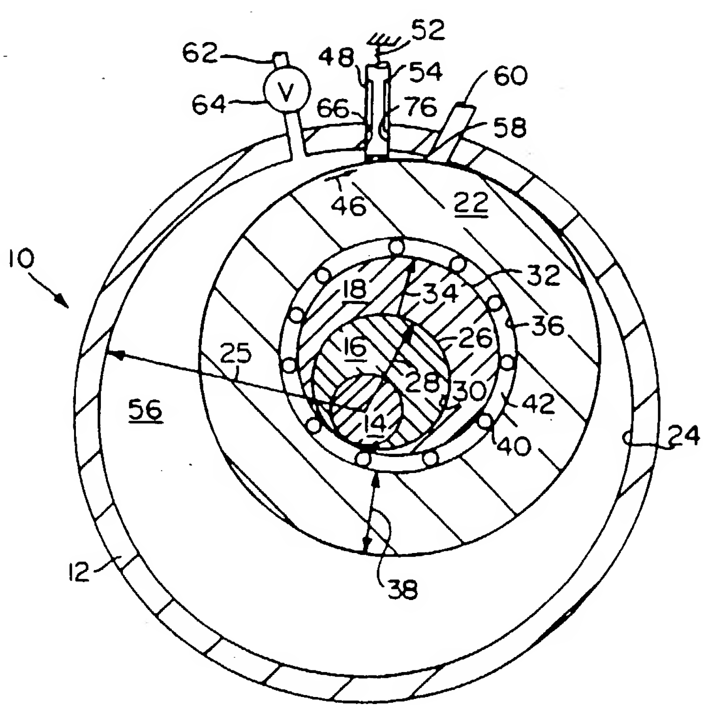
(54) Title: TWIN OPPOSING ECCENTRIC MOUNT FOR A ROLLING PISTON COMPRESSOR


(57) Abstract

An eccentric mount apparatus for a rolling piston compressor (10) includes a casing (12) having an inner radius (25). A rotary shaft (14) is mounted within the casing. A first eccentric (16) has a first greatest eccentric distance (28) and is rotationally fixed relative to the rotary shaft (14). A second eccentric (18) has a second greatest eccentric distance (34). A rolling piston (22) has a bore (36) formed therein, the second eccentric (18) being rotationally encased within the bore. The second eccentric is formed with an inner radial aperture (30), the inner radial aperture (30) being mounted to concentrically rotate about the first eccentric (16). Any opposing angular rotation between the first eccentric and the second eccentric results in an outward radial displacement of the rolling piston (22) thereby initiating contact between the rolling piston and the casing (12). A plurality of rolling elements (40) are disposed between said bore (36) and the second eccentric (18).

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# TWIN OPPOSING ECCENTRIC MOUNT FOR A ROLLING PISTON COMPRESSOR

## BACKGROUND OF THE INVENTION

This invention relates generally to compressors, and more particularly to a rolling piston compressor wherein the piston is continually biased against the side of the compressor casing during rotation of the compressor.

Rolling piston compressors, whose piston is mounted on an eccentric and contact the side of the casing are known in the art. However, precise machining of the piston is required to seal between the side of the piston and the casing to prevent high pressure fluid escaping to a low pressure location.

The casing itself may not be perfectly formed either. Therefore, regardless of how perfectly the rolling piston is machined, the piston may have a tendency to lift off from contact with the casing during certain points during rotation of the piston. This permits the passage of pressurized gas between the rolling piston and the casing.

If the piston itself is not securely mounted, then there will be a tendency for gas pressures created during the compression process to lift the piston from contact with the casing. This liftoff similarly permits the passage of pressurized gas between the piston and the casing.

Even in rolling piston compressors originally machined to extremely close tolerances, a considerable clearance will develop between the piston and the casing after considerable

wear of the piston and the casing. This clearance leads to compressor inefficiency.

The foregoing illustrates limitations known to exist in present rolling piston compressors. Thus, it is apparent that it would be advantageous to provide an alternative directed to overcoming one or more of the limitations set forth above. Accordingly, a suitable alternative is provided including features more fully disclosed hereinafter.

## SUMMARY OF THE INVENTION

In one aspect of the present invention, this is accomplished by providing an eccentric mount apparatus for a rolling piston compressor including a casing having an inner radius. A rotary shaft is mounted within the casing. A first eccentric has a first greatest eccentric distance and is rotationally fixed relative to the rotary shaft. A second eccentric has a second greatest eccentric distance. A rolling piston has a bore formed therein with the second eccentric rotationally encased within the bore. The second eccentric is formed with an inner radial aperture, the inner radial aperture is mounted to concentrically rotate about the first eccentric. Any opposing angular rotation between the first eccentric and the second eccentric results in an outward radial displacement of the rolling piston, thereby initiating contact between the rolling piston and the casing. A plurality of rolling elements are disposed between said bore and the second eccentric.

The foregoing and other aspects will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing figures.

## BRIEF DESCRIPTION OF THE DRAWING FIGURES

Fig. 1 is a cross sectional end view illustrating an embodiment of a rolling piston compressor with a twin eccentric mount of the instant invention, with greatest eccentricity of the first eccentric being on the opposite side of the rotary shaft from the greatest eccentricity of the second eccentric.

Fig. 2 is a sectional end view , similar to Fig. 1, except with the greatest eccentricities of the two eccentric being nearly on the same side of the rotary shaft;

Fig. 3 is a cross sectional side view of the rolling piston compressor of Fig. 2, illustrating the flow through cooling features of the instant invention;

Fig. 4 is an exploded view of the seal 80 illustrated in Fig. 3; and

Fig. 5 is a sectional end view, similar to Fig. 2, of an alternate embodiment of roller piston compressor.

## DETAILED DESCRIPTION

A rolling piston compressor is shown generally at 10. The key elements of the compressor are a casing 12, a rotary shaft 14 with a first eccentric 16 radially integrated thereon, a second eccentric 18 surrounds the first eccentric 16, a rolling piston 22 with rolling elements 40 spaced between the second eccentric 18 and the rolling piston 22.

The casing 12 has an aperture 24 with a radius 25 formed therein. As the rolling piston 22 is displaced as the shaft rotates, it is desired to maintain contact between

the rolling piston and the wall of the aperture 24. The rotary shaft 14, first eccentric 16, second eccentric 18, rolling elements 40 and the rolling piston 22 all interact to maintain this contact,as described below.

The first eccentric 16 has a first circumradial surface 26 which has a first greatest eccentric distance 28. The first eccentric is integrated on the rotary shaft 14. The second eccentric 18 has an inner radial aperture 30 which rotatably encases the first circumradial surface 26.

There is a plain bearing fit between the first circumradial surface 26 of the first eccentric 16 and the inner radial aperture 30 of the second eccentric 18. The second eccentric has a second circumradial surface 32 with a second greatest eccentric distance 34.

The first and the second eccentric 16, 18 relate such that the greater the angle between the first eccentric distance 28 and the second eccentric distance, the further the rolling piston 22 will be from the aperture wall 24.

When the angle between the first greatest eccentric distance 28 and the second greatest eccentric distance 34 is at it's minimum permissible angle, the rolling piston 22 will contact the wall of the casing 12. The present invention is concerned about making and maintaining this contact dynamically, while ensuring that the contact does not increase to such a point as to result in excessive difficulty in rotation of the eccentrics should an irregularity be encountered along the wall of the aperture 24. Fig. 2 illustrates the configuration between the two eccentrics that the compressor should be in during counter-clockwise rotation of the compressor.

However, if the first greatest eccentric distance 16 and the second greatest eccentric distance are on opposite sides of the rotary shaft 14 (as illustrated in Fig. 1), then the second eccentric 18 will be at it's minimum eccentricity with respect to the rotary shaft 14.

In Figs. 1 and 2, the rolling piston 22 has a bore 36 formed therein. The second eccentric 18 is mounted within the bore 36. The rolling piston has a uniform radial thickness 38. There are a plurality of rolling elements 40 which are disposed between the second eccentric 18 and the rolling piston 22.

The bore 36 of the rolling piston 22 forms the outer race, while the second circumradial surface 32 of the second eccentric 18 forms the inner race which supports the rolling elements 40. Each rolling element rides in a void 42.

The first greatest eccentric distance 28, the second greatest eccentric distance 34, the thickness of the void 42 of the rolling elements 40 and the uniform radial thickness 38 of the piston sum to a distance which exceeds the radius 25 of the aperture 24. The first greatest eccentric distance 28 and the second greatest eccentric distance 34 therefore cannot be collinear when the two eccentrics 16,18 are mounted within the casing 10.

When the rotary shaft 14 rotates in counter-clockwise direction 44. the first eccentric 16 rotates within the inner radial aperture 30 formed in the second eccentric 18. As the first greatest eccentric distance 28 becomes more collinear with the second greatest eccentric distance 34, the rolling piston 22 travels radially outwardly towards the casing 12.

When the rolling piston 22 contacts the casing 12, the displacement of the rolling piston 22 follows the rotation of the first eccentric 16, while continuing to rotate around its mounted axis about the second eccentric 18. The interactive force of the first eccentric 16 on the second eccentric 18, as well as the centrifugal force caused by the rolling piston travelling around the aperture 24 causes the rolling piston to be biased into contact with the casing. The biased rolling piston 22 will maintain contact with the casing 12 regardless of the casing 12 or rolling piston 22 geometric surface irregularities, such as ovality, eccentricity, etc.

Centrifugal force, which is amplified by the interaction of the first eccentric 16 and the second eccentric 18, and the driving torque applied to the rotary shaft 14 overcomes the gas pressures exerted by the gas being compressed onto the rolling piston 22 and the casing 12 (which tend to lift off the rolling piston 22). By precisely regulating the above geometries, the operation of the rolling piston compressor can be precisely designed for the specific compressor size or the fluid being compressed.

Since there is firm contact between the rolling piston 22 and the casing 12, the rolling piston 22 will roll (not slide) relative to the casing about outer eccentric 18. This will cause rolling piston 22 to rotate in one direction 46 as the rotary shaft 14 rotates in direction 44.

A vane 48 extends through the casing 12, into the aperture 24, and is biased into continual contact with the rolling piston 22. As the rolling piston 22 travels about an axis 50 of the shaft 14, the vane 48 will rise and fall, but a resilient means 52 will maintain the contact between

the vane 48 and the rolling piston. A seal 54 is formed between the vane 48 and the rolling piston 22.

The vane 48 acts to provide a boundary between a first low pressure region 56 and a second high pressure region 58. As the rolling piston rotates, the pressures in the first and the second pressure regions 56, 58 will vary. However, the vane 48 will permit a pressure differential.

There is a fluid inlet 60 which supplies fluid to the aperture 24. There is also a fluid outlet 62 which permits fluid passage from the aperture 24. The fluid inlet 60 and the fluid outlet 62 are mounted on radially opposed sides of the vane 48. Connected to the fluid outlet 62 is a valve means 64 which permits fluid to exit the aperture 24 through the fluid outlet 62, but does not permit fluid to return to the aperture through the fluid outlet 62.

A vane groove 66 is formed in the casing 12, in which the vane 48 is securely, yet slidingly disposed. The seal 54 is formed about the circumference of the vane 48 to prevent fluid from passing from the aperture 24, through the vane groove, to the atmosphere.

As illustrated in Fig. 3, cooling fluid is passed through an interior space 70 formed in the rolling piston 22 to directly cool the rolling piston 22, the rotary shaft 14, the first eccentric 16, the second eccentric 18 and the rolling elements 20. A fan 72 aids in forcing the cooling fluid into the interior space 70 and about the different elements contained within the compressor.

To fully seal the rolling piston 22 (as illustrated in Figs. 3 and 4), an end cover 74 is attached to the casing 12 at one or both axial ends. A groove 76 is formed at both

axial ends 78 of the rolling piston 22, and a seal 80 ensures limiting passage of pressurized fluid between opposed sides of the seal 80. The seal 80 includes a sealing portion 79 and O-ring 81.

The greater the pressure is in the first and the second pressure regions 56, 58, the greater will be the tendency to flatten the O-ring 81 (horizontally as illustrated in Fig. 4), thereby increasing the force with which sealing portion 79 is exerted against the casing 12. Alternately, any well known axial spring means known in the art may be substituted for the O-ring.

Increasing the force exerted by sealing portion 79 against the casing 12 also exerts a biasing (or retarding) force on the rolling piston 22 opposed to the direction of rotation of the first eccentric. This resistance will maintain the two eccentrics extended as much as possible, wherein the rolling piston 22 will contact the inner wall of the casing 12 as illustrated in Fig. 2. The sealing portion may be chosen for the specific application. For example, rolling piston compressors of this type may be used in non lubricated machines as well as lubricated rolling piston compressors.

A second biasing system is illustrated in Fig. 5 in which a spring 95 having tab 97 (which restricts relative rotation between spring 95 and the second eccentric 18) is located between the first eccentric 16 and the second eccentric 18. The spring acts to bias the second eccentric 18 in a clockwise direction relative to the first eccentric 16 as illustrated in Fig. 5.

This embodiment is especially useful where there are no sealing portions 79 as illustrated in Fig. 4, to retard

rotation of the second eccentric 18 within the casing 12. In this embodiment, the second eccentric includes both an inner portion 18a, and outer portion 18b and the spring 95.

The two biasing schemes described in the prior several paragraphs both function to bias the second eccentric 18 relative to the first eccentric 16. The second biasing scheme does this directly while the second biasing scheme accomplishes this result by retarding the travel of the rolling piston 22 (which the second eccentric 18 is constrained within), and thereby causing a biasing force to be produced as the second eccentric is rotationally displaced. Specific designs may be configured by combining both of the above biasing schemes.

A rolling piston compressor similar to Fig. 5 can be designed incorporating any suitable biasing means between the second eccentric 18 and the casing 12. While not illustrated in any of the Figs., this embodiment would use biasing means similar to those illustrated in Figs. 2,3,5 or any other retardation device well known by persons skilled in the art.

The instant configuration presents several advantages. Initially, it is not critical to machine the casing 12, the rolling piston 22, covers 74 or the eccentric to the extremely precise tolerances to which the prior art rolling piston compressors had to be previously machined to. The present configuration permits biasing of a rolling piston compressor with a minimal number of machine elements. All of the machine elements of the instant application are rigid members.

Also, if an eccentric, a rolling piston or a casing becomes worn or is improperly machined, with the instant

configuration it becomes possible to replace or remachine the worn part without having to scrap the entire machine, as is the case with the prior art compressors. The instant invention is much more serviceable than the prior art compressors.

The present invention permits altering the first greatest eccentric distance 28, second greatest eccentric distance 34 and the width of the rolling piston 22 and the bearings 40 compared to the diameter of the aperture 24 to optimize the rolling piston compressor depending upon fluid compression and delivery, rotational velocity and dimensions of the casing 12.

For example, the greater a ratio between the second greatest eccentric distance 34 to the first greatest eccentric distance 28, the greater will be the biasing force of the rolling piston 22 against the side of the casing 12. The smaller the angle between the two greatest eccentric distances 28, 34, the greater will be the tendency to hold or interlock the bias of the rolling piston 22 against the side of the casing.

While this invention has been illustrated and described in accordance with a preferred embodiment, it is recognized that other variations and changes may be made therein without departing from the invention as set forth in the claims.

Having described the invention, what is claimed is:

1. An eccentric mount apparatus for a rolling piston compressor comprising:

a casing having an inner radius;

a rotary shaft mounted within the casing;

a first eccentric having a first greatest eccentric distance, being rotationally fixed relative to the rotary shaft;

a second eccentric having a second greatest eccentric distance;

a rolling piston having a bore formed therein, with the second eccentric rotationally encased within the bore;

the second eccentric is formed with an inner radial aperture, the inner radial aperture is mounted to concentrically rotate about the first eccentric, any opposing angular rotation between the first eccentric and the second eccentric results in an outward radial displacement of the rolling piston, thereby initiating contact between the rolling piston and the casing; and

a plurality of rolling elements disposed between said bore and the second eccentric.

2. The apparatus as described in claim 1, wherein the sum of the first greatest eccentric distance plus the second greatest eccentric distance, plus a diameter of the rolling elements, plus a uniform radial thickness of the piston is greater than the inner radius of the casing.

3. The apparatus as described in claim 1, wherein the fit between the inner radial aperture and the first circumradial eccentric surface is a sliding plain bearing fit.

4. The apparatus as described in claim 1, wherein rotation of the first eccentric in a first rotary direction will cause the rolling piston to rotate in a second rotary direction, opposite the first direction thereby presenting an opposing relative velocity between the rolling piston and the second eccentric.

5. The apparatus as described in claim 4, wherein rotation of the first eccentric will result in a locked relation between the first eccentric and the second eccentric for any instantaneous shaft rotation, and constantly adjustable to provide optimum tracking and rolling contact of the piston.

6. The apparatus as described in claim 1, further comprising:

a vane extending circumferentially inwardly into the casing, and biased into continual contact with the rolling piston.

7. The apparatus as described in claim 6, further comprising:

a vane groove formed in the casing, in which the vane is slidably disposed.

8. The apparatus as described in claim 6, further comprising:

a resilient means for biasing the vane into contact with the rolling piston.

9. The apparatus as described in claim 1, wherein the rolling piston comprises:

a cylinder with an outer cylindrical periphery with two axial ends, the outer cylindrical periphery contacts the casing; and

end seals mounted within grooves formed on the axial ends of the rolling pistons which seals between the piston and the end covers.

10. The apparatus as described in claim 9, wherein the end seals further comprises:

O-rings which are compressed in assembly to exert an initial axial sealing force and which, in discharge air pressure, get supplemented to get proportionally greater sealing force as the compressor is operated at proportionally higher pressures.

11. An eccentric mount apparatus for a rolling piston compressor comprising:

a casing having an inner radius;

a rotary shaft mounted within the casing;

a first eccentric having a first greatest eccentric distance which is rotationally fixed relative to the rotary shaft;

a second eccentric having a second greatest eccentric distance, formed with an inner radial aperture, the inner radial aperture rotationally encasing the first circumradial eccentric surface;

a rolling piston having a bore formed therein, with the second eccentric rotationally encased within the bore;

a plurality of rolling elements disposed between said bore and the second eccentric; and

biasing means, applied between the casing and the second eccentric for resisting angular displacement of the second eccentric relative to the first eccentric within the bore, thus causing the two eccentrics to reach their maximum permissible combined eccentricity to displace the rolling piston radially outward into contact with said casing.

12. The apparatus as described in claim 11, wherein the biasing means comprises:

spring means disposed between the first eccentric and the second eccentric.

13. The apparatus as described in claim 11, wherein the biasing means comprises:

friction means, located between the rolling piston and the casing, for resisting displacement of the rolling piston.

14. The apparatus as described in claim 13, wherein the friction means comprise:

a seal.

15. The apparatus as described in claim 11, wherein the biasing means comprises:

friction means, located between the second eccentric and the casing, for resisting displacement of the rolling piston.

16. An eccentric mount apparatus for a rolling piston compressor comprising:

a casing having an inner radius;

a rotary shaft mounted within the casing;

a first eccentric having a first greatest eccentric distance, is rotationally fixed relative to the rotary shaft;

a second eccentric having a second greatest eccentric distance, formed with an inner radial aperture, the inner radial aperture rotationally encasing the first circumradial eccentric surface;

a rolling piston having a bore formed therein, with the second eccentric rotationally encased within the bore;

a plurality of rolling elements disposed between said bore and the second eccentric; and

a biasing device applied to the second eccentric, whereby rotational acceleration of the first eccentric equals or exceeds the rotational acceleration of the second eccentric during rotation of the first eccentric, thus causing the two eccentrics to reach their maximum permissible combined eccentricity relative to said rotary shaft resulting in displacement of the rolling piston into contact with said casing.

17. The apparatus as described in claim 16, wherein the biasing means comprises:

spring means disposed between the first eccentric and the second eccentric.

18. The apparatus as described in claim 16, wherein the biasing means comprises:

friction means, located between the rolling piston and the casing, for resisting displacement of the rolling piston.

19. The apparatus as described in claim 18, wherein the friction means comprise:

a seal.

20. The apparatus as described in claim 16, wherein the biasing means comprises:

friction means, located between the second eccentric and the casing, for resisting displacement of the rolling piston.

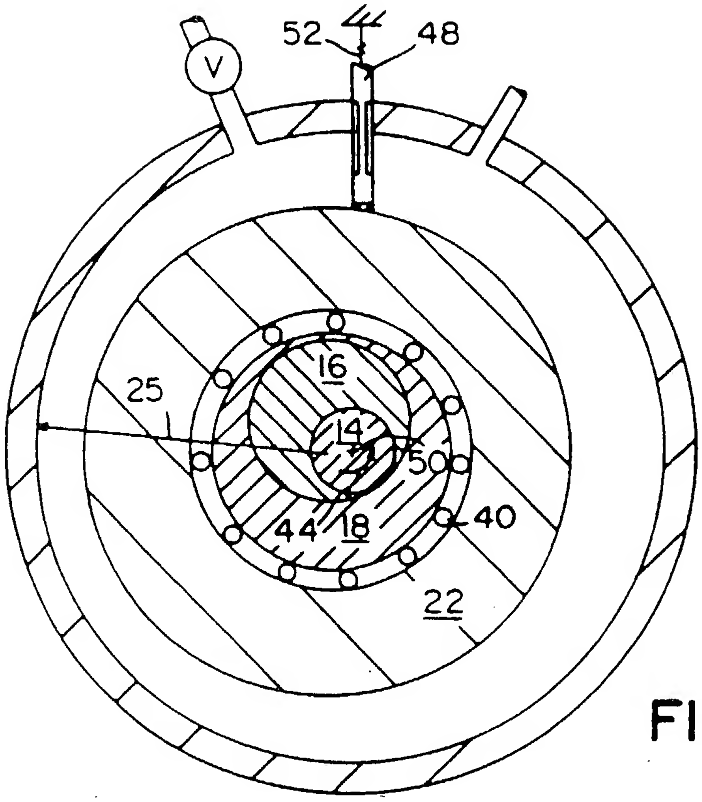

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FIG. 1

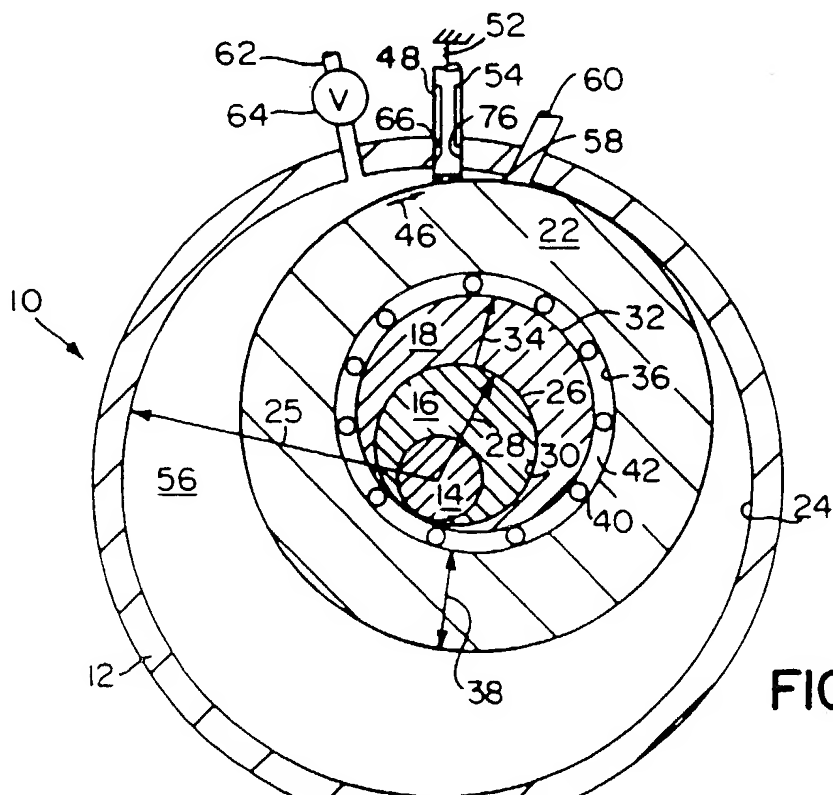

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FIG. 2

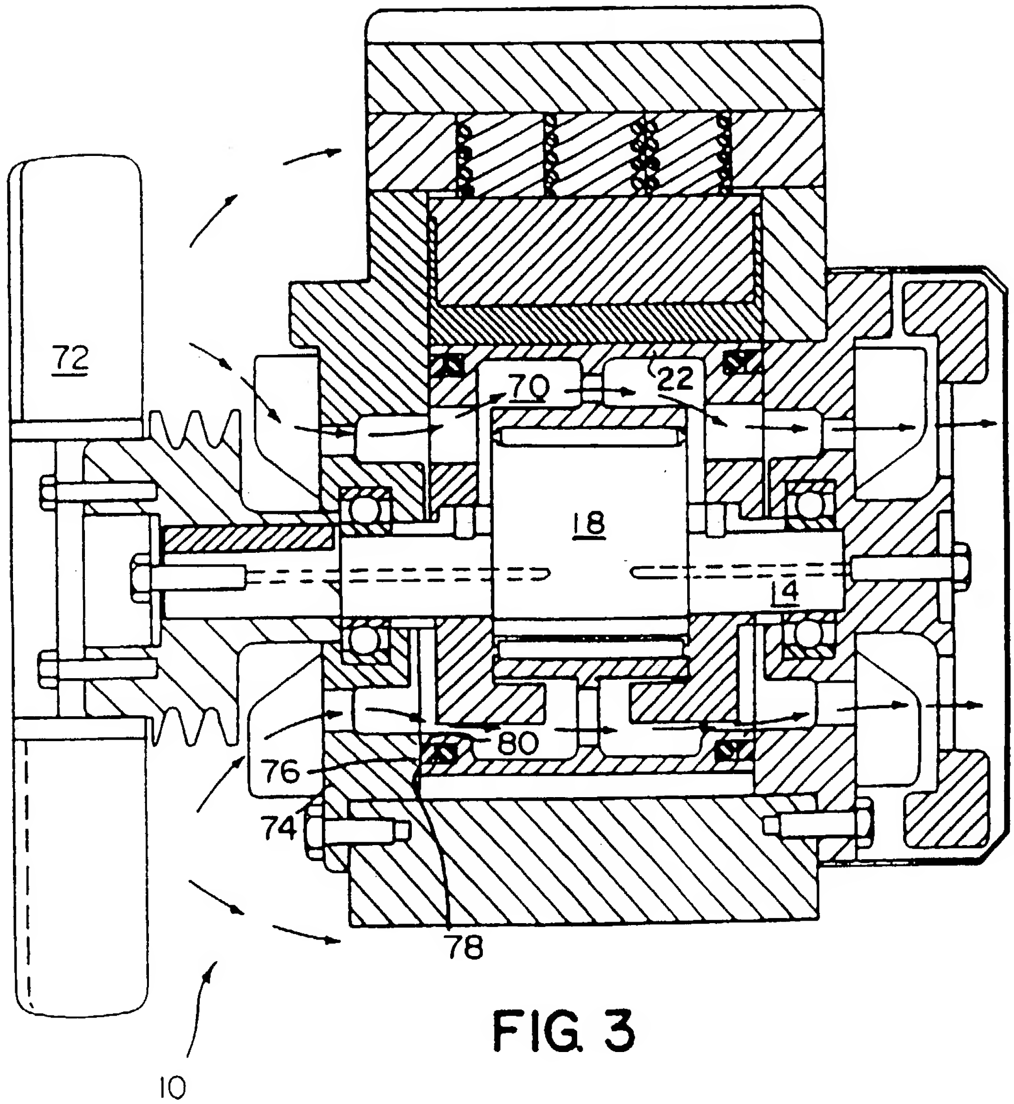


FIG. 3

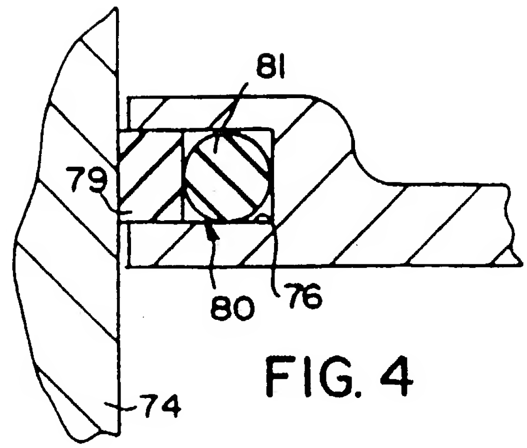
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FIG. 4

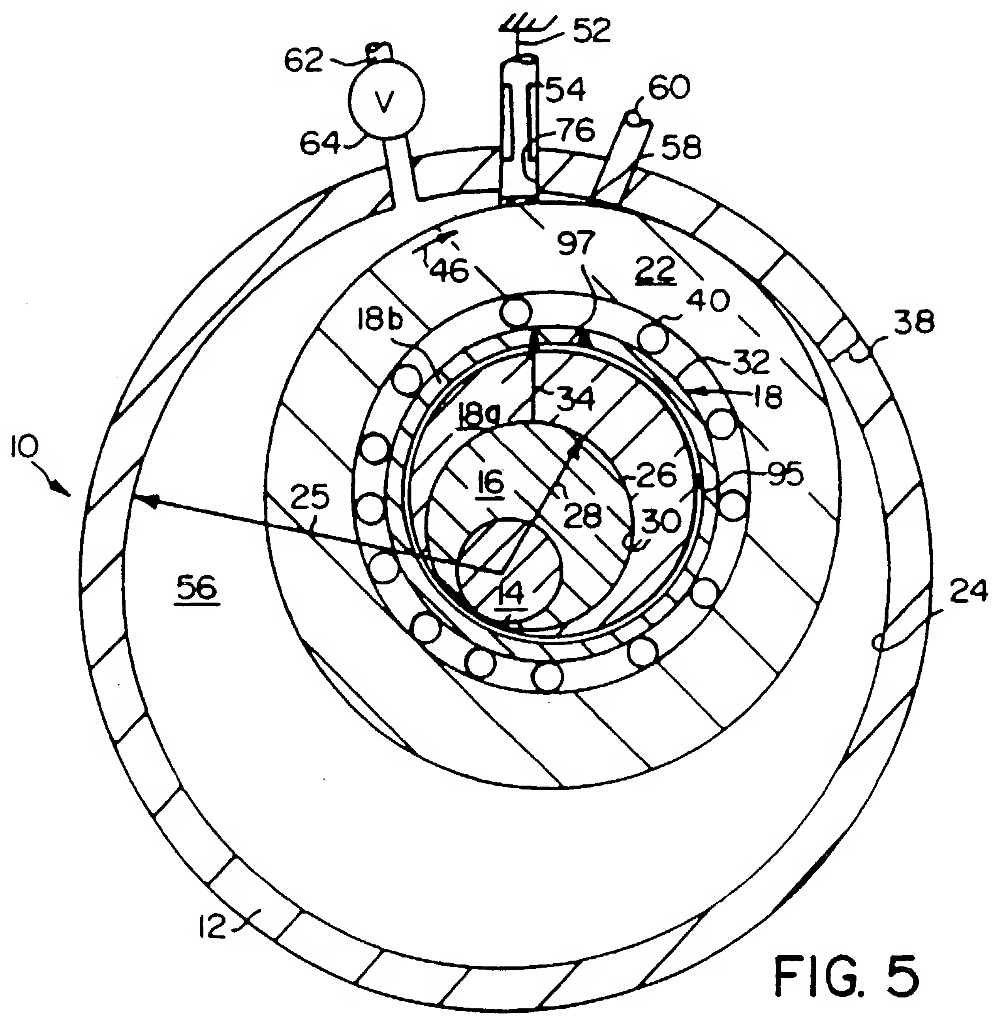
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FIG. 5

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 91/09074

**I. CLASSIFICATION OF SUBJECT MATTER** (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F04C29/00

**II. FIELDS SEARCHED**

Minimum Documentation Searched[7]

| Classification System | Classification Symbols |
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| Int.Cl. 5 | F04C ; F01C |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

**III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]**

| Category° | Citation of Document,[11] with indication, where appropriate, of the relevant passages[12] | Relevant to Claim No.[13] |
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| Y | | 2,9,10, 11,16 |
| Y | FR,A,2 280 808 (ROBERT BOSCH) 27 February 1976<br>see page 1 - page 2; figure | 2 |
| Y | DE,A,2 509 537 (ROBERT BOSCH) 16 September 1976<br>see page 2, line 11 - line 25<br>see page 3, line 9 - line 28<br>see page 4 - page 6; figures | 11,13, 14,16, 18,19 |

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**IV. CERTIFICATION**

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
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| 03 SEPTEMBER 1992 | 24.09.92 |
| International Searching Authority<br>EUROPEAN PATENT OFFICE | Signature of Authorized Officer<br>KAPOULAS T. |

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International Application No PCT/US 91/09074

| III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET) | | |
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# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9109074 SA 56819

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 03/09/92
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| GB-A-390443 | | None | | |



For more details about this annex : see Official Journal of the European Patent Office, No. 12/82